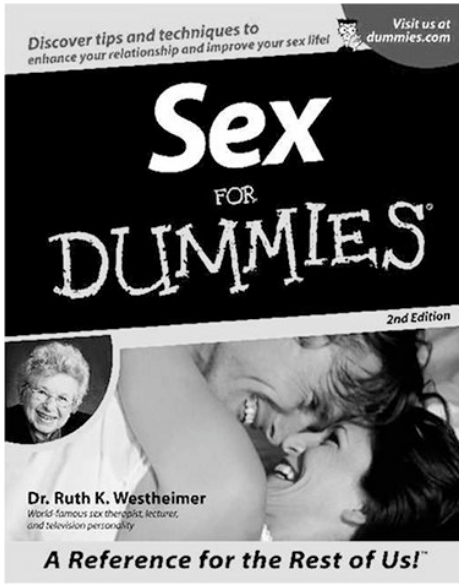


Sexual Selection

BIOL 4415 / 5415

What's the point of sex, anyway?

- One would think that asexuals would have greater fitness—since every asexual can reproduce, whereas it takes two sexuals to reproduce
  - This is the *twofold cost of sex*, pointed out by John Maynard Smith (1920-2004)
- Sexual reproduction also carries costs with it (cost of seeking mates, producing gametes, etc.)
- There's also the risk that an organism which mingles its genes with a partner will produce offspring with a less-fit genotype
- So why is sexual reproduction nearly universal?

What's the point of sex, anyway?

- Sexual reproduction turns out to be evolutionarily quite beneficial:
  - It breaks up linkage disequilibrium.
  - It breaks *Müller's ratchet* (the tendency of an asexual line to accumulate more and more negative mutations)
  - It generates variability, which is beneficial in itself, especially if population is exposed to changing environments or pathogens/parasites
    - Study of New Zealand freshwater snails: sexual reproduction is more common in populations exposed to flatworm parasites than in parasite-free populations
- Sex may have evolved very early on in evolutionary history, as a means of DNA repair (according to one hypothesis)

Two main aspects of sexual selection

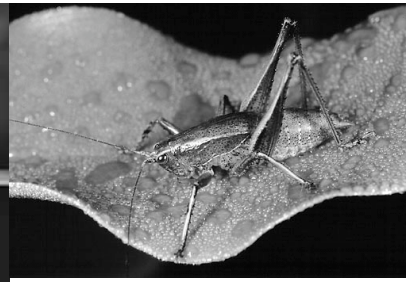
- Competition between members of one sex for "breeding rights"
  - Usually, this is competition between males
- Selection of mates by members of one sex
  - Usually this amounts to choice by the females
- Both of these may act independently of, together with, or in opposition to natural selection

Usually males fight over females, and females are choosy about which males they allow to mate with them. . .

Male elk in the Canadian Rocky Mountains "bugling" and fighting, borrowed from JDM Multimedia

But there are exceptions. . . and looking at these exceptions helps to understand why sexual selection acts the way it does.

Mormon cricket,
Anabrus simplex



Australian katydid,
Requena sp.

(Images plagiarized from the Nelson-Bohart Bug Gallery and the Australian Impressions photo gallery)

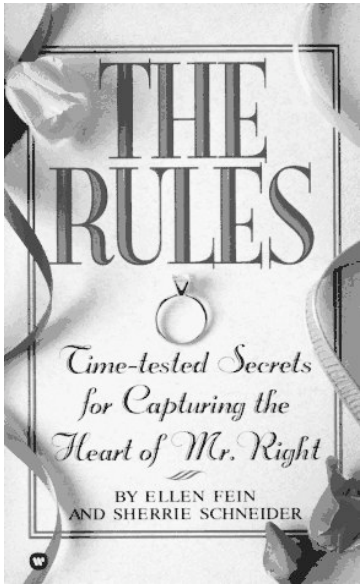
Case Study: Katydids

- Male katydids produce a *spermatophylax*, or sperm packet, made of protein and containing sperm.
  - In "Mormon crickets" the spermatophylax may amount to 25% of a male's total body weight.
- At mating, females eat the spermatophylax, which is quite nutritious.
- Female katydids compete with each other for access to males—the reverse of the usual pattern!
- Competition is strongest when food is scarce.

Female cricket preparing to feed on a male's spermatophylax

Pipefish are another “exception that proves the rule.”

At mating, female pipefish lay eggs inside a specialized pouch on the male’s belly, and he carries them around and eventually gives birth. Male pipefish are choosy about females, and females compete with each other for access to “choice” males.



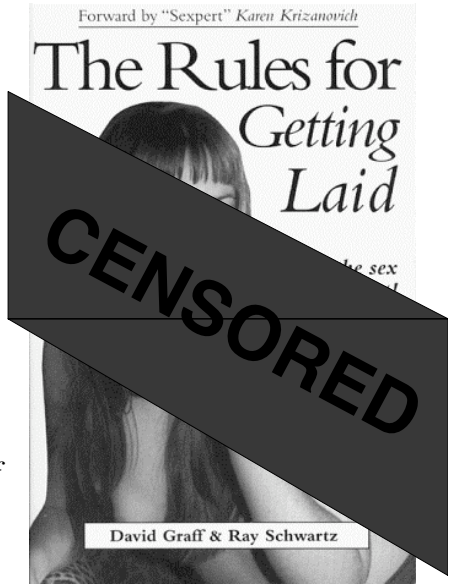
The Rules

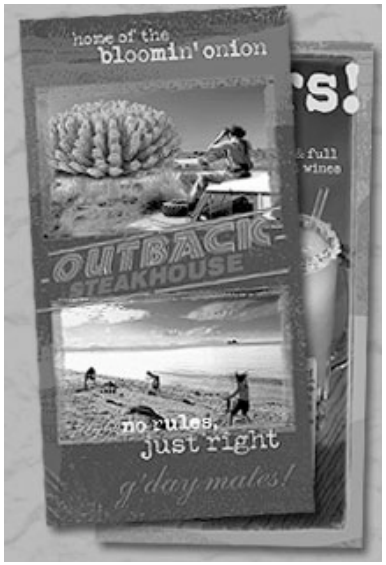
1. Whichever sex invests more energy in reproduction “has more to lose”, and has fewer opportunities to reproduce. Selection will favor behavior patterns by that sex which select only high-quality mates.

The Rules

2. Whichever sex invests less energy in reproduction can increase its fitness by reproducing as often as possible.

This difference between the “long-term interests” of sexes is called *asymmetry of sex*.





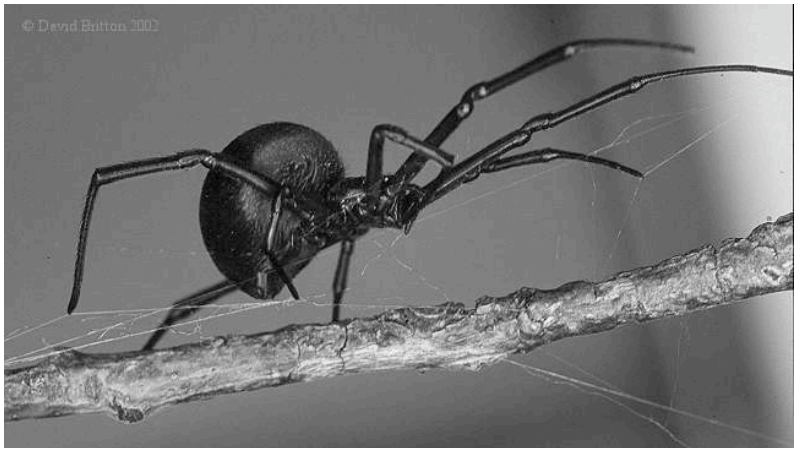
The Rules?

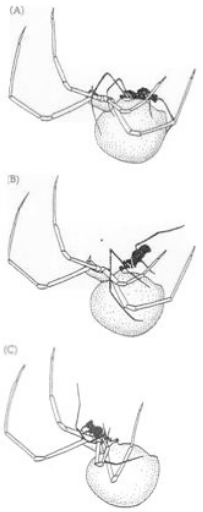
NO RULES. JUST RIGHT.®

In the real world, however, so many other factors can affect the evolution of sexual behavior that it's hard to really come up with *any* rules that don't have exceptions all over the place. Consider a famous Aussie organism—no, not the Bloomin' Onion. . .

. . . but rather the Australian redback spider, *Latrodectus hasselti*, a close relative of our black widow spiders.

(Image borrowed with thanks from David Brittons's WWW page)





Pity the male redback spider. . .

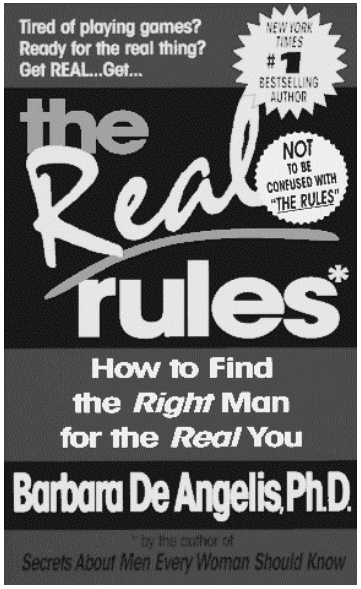
- Male redbacks are much smaller than females, and don't live as long (2-4 months for males, 2 years for females).
- A male mating with a female must somersault directly onto the female's jaws.
- The female usually then eats the male as he copulates—a behavior known either as "sexual cannibalism" or "copulatory suicide".

How can this be adaptive?

- Males who are eaten actually have higher fitness!
  - Cannibalism has been shown to decrease the chance that a female will accept mating with another male later.
  - It also boosts the female's nutrition, making her that much better able to lay and care for eggs. . .
  - . . . and copulation goes on longer when the male is being eaten, allowing him to transfer more sperm
  - In the few cases where a male does survive after mating, he never leaves the female's web, never feeds, and eventually dies.
    - Source: M. C. B. Andrade, *Science* 1996

The Rules, III

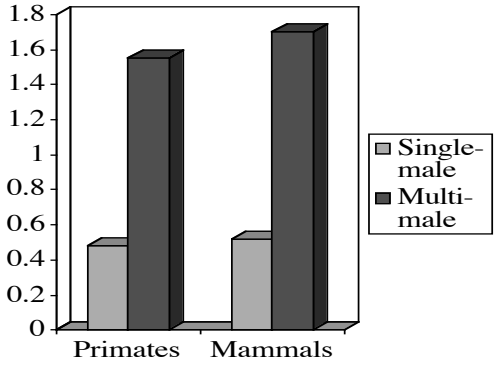
- Male-male competition may be a fight to the death when the stakes are high enough
- But such competition may end up harmful to both competitors!
- Thus, natural selection often favors the evolution of non-lethal “ritual combat” or displays.



In northern elephant seals, successful males have "harems" of females. Fewer than one-third of the males copulate at all, and the top five males may do 50% of the copulating. Male-male competition is vicious and frequently lethal.

In species where not so much is at stake, less lethal forms of male competition may be selected for—such as "neck-wrestling" in these giraffes, or "bugling" and antler fights in elk and deer.

A more subtle form of male-male competition is *sperm competition*. If females mate with several males, selection will tend to favor males who produce more sperm.



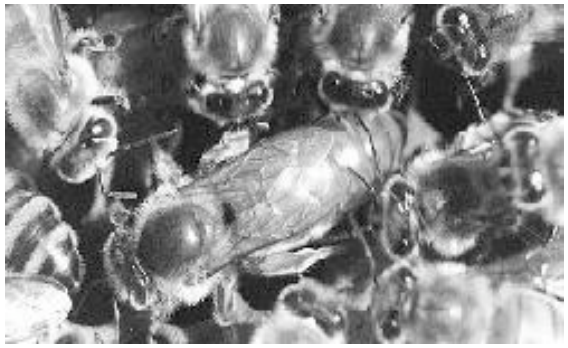
This graph shows the mean size of the testes, relative to body size, in both primates and in a wide range of mammals. In species where a female mates with several males, the males have large testes and produce much sperm.

(Source: Kenagy and Trombulak, *Journal of Mammalogy* 67: 1-22)

Selection may favor males who engage in "mate-guarding", staying close to the females that they've mated with—as in these Nebraska tiger beetles.

Selection may also favor males who can scrape out their rivals' sperm with a special penis attachment, as is the case in dragonflies and damselflies. . .

. . . and selection may also favor males who keep their sperm from falling out of the female's body, by letting their copulatory organs break off and stay embedded in the female—as is the case in honeybees and some spiders. (Except that in spiders, the male's organ is actually one of his legs, but that's another story.)



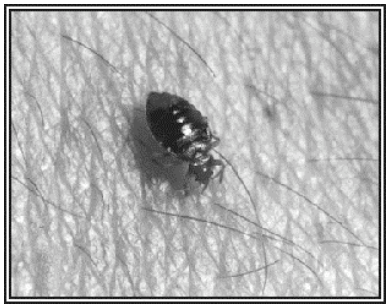
It gets worse. . .

This is the "intromittent organ" of the bean weevil *Callosobruchus maculatus* (actual size is 0.8 mm). The spines at the tip cause serious wounds inside the female's genital tract.

This definitely tends to discourage the female from mating with anyone else. . .

(Source: Crudgington and Siva-Jolly, *Nature* 407: 855-856.)

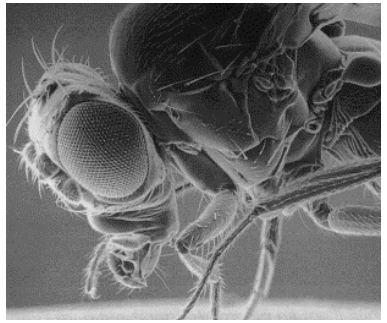
In many insects and spiders, as well as some rodents, bats, and primates, a male deposits a "mating plug" in the female's oviduct. . .



. . . but that doesn't stop male bedbugs, who can mate by stabbing females in the back with their unusually sharp and hard phalluses, and directly injecting sperm.

And the semen of some *Drosophila* (fruit fly) species packs a *triple* whammy: it contains chemicals that:

- decrease the female's "libido" (or at any rate, lower the odds that she'll mate with someone else)
- increase her egg production
- kill or disable the sperm cells of other males. (Unfortunately, they poison the female as well.)



Infanticide can be seen as yet another form of male-male competition.

Indian langur monkeys live in groups of one male and several females. A strange male may take over the group; if successful, he will try to kill all infants in the group. . . causing the females to come into estrus ("heat") sooner.

Male lions are noted for infanticidal behavior as well. . . .

Since a female with a newborn cub won't be in estrus for another eighteen months, males that take over a pride attempt to kill the cubs so that the females are receptive sooner. (However, the females do fight to defend their own cubs. Check out the Lion Research Center for some rather disturbing videos of this behavior. . .)